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Citation for published version:

Havens, L, Bao, M, Pschetz, L, Bach, B & Bell, C 2019, PaxVis: Visualizing Peace Agreements. in Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems., LBW0268. DOI: 10.1145/3290607.3313070

Digital Object Identifier (DOI):

[10.1145/3290607.3313070](https://doi.org/10.1145/3290607.3313070)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Peer reviewed version

Published In:

Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems

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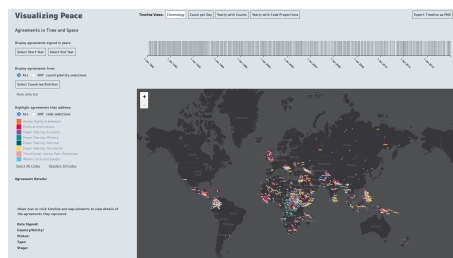


Figure 1: Agreements in Time and Space



Figure 2: Agreement Sequence Comparison



Figure 3: The *Chronology* timeline view from Agreements in Time and Space, displaying PAs from 2010 through 2015.

¹www.un.org/development/desa/disabilities/envision2030-goal16.html

PaxVis: Visualizing Peace Agreements

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ABSTRACT

Peace is not only a universal concern,¹ but also a complex process of negotiations between select groups (i.e. policy makers, mediators, scholars and civil society groups) [4]. In this paper we present *PaxVis*, a platform of three interactive data visualizations for a large database of peace agreements (PA-X), developed to support comparative analysis of peace processes and improve understanding of the dynamics behind the establishment of peace.

CHI'19, July 2019, Glasgow, Scotland, UK

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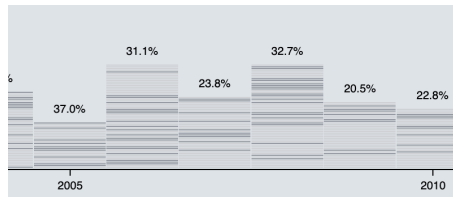


Figure 4: Close up of the Yearly with Proportions timeline view from Agreements in Time and Space with the filter Women, Girls and Gender selected.

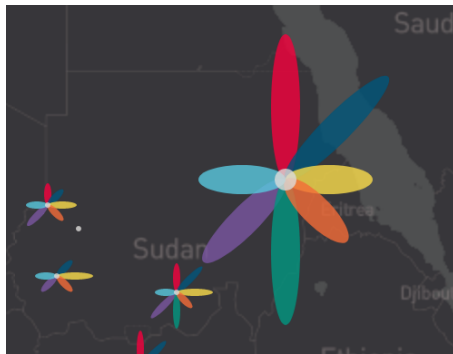


Figure 5: Close up view of a clicked PA on the map.

²www.beyondbordersscotland.com

³www.peaceagreements.org

⁴www.peaceagreements.org/files/PA_X_codebook_Version1_Feb_20_20.pdf

CCS CONCEPTS

• **Information systems** → **Search interfaces**; • **Human-centered computing** → **Visualization design and evaluation methods**; *Human computer interaction (HCI)*.

KEYWORDS

data; visualization; HCI; peace; peace agreements; peace processes.

ACM Reference Format:

Lucy Havens, Mengting Bao, Larissa Pschetz, Benjamin Bach, and Christine Bell. 2019. PaxVis: Visualizing Peace Agreements. In *Proceedings of ACM CHI 2019 Conference (CHI'19)*. ACM, New York, NY, USA, 6 pages. https://doi.org/10.475/123_4

1. INTRODUCTION

Efforts to support peace in HCI focus on exploring peace data standards [7], guidelines for peace-promoting technologies [11, 14] and recommendations to overcome challenges in peace research [13]. We contribute to these efforts with *PaxVis*, a data visualization facilitating large-scale peace agreement analysis. The roots of *PaxVis* lie in the *PeaceTech* collaboration across the University of Edinburgh's Schools of Law, Informatics and Design, and Beyond Borders Scotland (a local NGO²), which aim to create digital tools and methods that support peace processes. In this paper, we explain the motivation for *PaxVis*, describe existing initiatives to analyze peace-related data, and demonstrate how *PaxVis* offers new peace research capabilities. Lastly, we outline future work for *PaxVis*.

2. MOTIVATION

The Peace Agreement Database (PA-X) is a publicly-available, searchable repository of peace agreements from around the world, written from 1990 through 2015.³ According to Bell and Badanjak [4], a peace process is “a formal attempt to bring political and/or military protagonists of conflict to...mutual agreement as to how to end the conflict.” Peace agreements (PAs) are “formal, publicly-available documents, produced after discussion with conflict protagonists” [4]. PA-X codes PAs along 225 dimensions, creating a hierarchical metadata scheme.⁴ Codes correspond to topics (i.e. human rights, gender) and have numerical values that indicate the amount of detail with which PAs address the topics. The PAs and their codes create over 30,000 data points for analysis [4].

Across the disciplines of social science, conflict resolution and law, scholars analyze peace agreements with the goal of understanding peace processes of the past to improve those of the future [2]. Their analysis involves open-ended questions characteristic of exploratory search [15]: the sequence of events in a peace process [5], legal implications of PAs [6], and trends in PAs [3] and peace processes [1]. PAs' hybrid nature complicates the analysis: PAs address both national and international law, serve as

⁵View online at: thegoose20.github.io/pax

The image shows a sidebar for the PaxVis application with the following sections:

- Display agreements signed in years:** Two input fields labeled "Select Start Year" and "Select End Year".
- Display agreements from:** Radio buttons for "ALL" and "ANY" (selected), followed by the text "country/entity selections". Below is a button labeled "Select Countries/Entities".
- Highlight agreements that address:** Radio buttons for "ALL" (selected) and "ANY", followed by the text "code selections". Below is a list of categories with corresponding colored squares:
 - Human Rights Framework (orange)
 - Political Institutions (red)
 - Power Sharing: Economic (purple)
 - Power Sharing: Military (green)
 - Power Sharing: Political (dark blue)
 - Power Sharing: Territorial (yellow)
 - Transitional Justice Past Mechanism (pink)
 - Women, Girls and Gender (light blue)
- At the bottom, two links: "Select All Codes" and "Deselect All Codes".

Figure 6: Filters from Agreements in Time and Space with Women, Girls and Gender selected.

⁶ucdp.uu.se

⁷ucdp.uu.se/downloads/

⁸peaceaccords.nd.edu/about

⁹comparativeconstitutionsproject.org

¹⁰www.constituteproject.org

¹¹www.tgpccloud.org/p4p/index.php?m=p4p

both treaties and constitutions, and both facilitate change and establish a new state [2]. We created a data visualization, PaxVis,⁵ as an interface to PA-X because the multidimensional capabilities of visualization support the exploratory nature of peace research. Relying on contextual design methods [18], we created PaxVis for peace researchers and negotiators.

3. RELATED WORK

Access to open and up-to-date data on peace processes is crucial for researchers, NGOs, civil society groups, policy makers and any participant in peace negotiations. As early as 1990, Schneiderman called for technologists to consider fundamental concerns such as “world peace” when creating user interfaces and information systems [17]. In 2011 Hourcade and Bullok-Rest introduced HCI for Peace “to build a research community dedicated to technologies to promote peace” [12]. PaxVis contributes to this research with a platform to analyze agreements written during peace processes.

Prior to the launch of PA-X, existing peace agreement datasets included fewer documents and focused more broadly on conflict and peace processes. The Uppsala Conflict Data Program (UCDP) created PAD, the Peace Agreement Dataset, for its Conflict Encyclopedia.⁶ The Encyclopedia visualizes conflict data to promote analysis of conflicts’ origination, spread and resolution. The visualizations display deaths, battles and types of violence, among other data⁷ that include only 197 PAs [9, 10]. PAM, the Peace Accords Matrix,⁸ also includes a smaller set of PAs than PA-X. Nonetheless, PAM and PA-X have similar motivations: to inform the writing of PAs during peace processes. Unlike UCDP, PAM does not have accompanying visualizations.

Similar to PA-X, the Comparative Constitution Project (CCP) and Peace Map visualize peace-related data. CCP focuses on only one type of agreement: constitutions. Through data visualizations⁹ and a searchable database of digitized constitutions,¹⁰ CCP guides legal scholars in promoting peace when writing constitutions [16]. With a narrower focus, Peace Map¹¹ has a narrower focus, drawing on several datasets to visualize peace agents’ locations and create a network among peace agents [8].

PA-X enables comparative analysis of PAs at an unprecedented scale, providing an online, public, centralized repository of over 1,500 PAs. PA-X improved access to peace data, making PAs available for search and download through coding each PA with 255 metadata fields and making PAs searchable by keyword. Nevertheless, comparative analysis of PAs across large time scales and geographic regions remained cumbersome: no interface existed that illustrated a high-level view of PA-X data. To address this gap, we created PaxVis to display PA-X data across temporal and geographic dimensions.

4. RESEARCH WITH PAXVIS

PaxVis has two exploratory data visualizations: *Agreements in Time and Space* (Figure 1) and *Agreement Sequence Comparison* (Figure 2). Agreements in Time and Space visualizes PAs in an integrated timeline and map. Users can choose a subset of PA-X data to visualize using filters in the left sidebar (Figure



Figure 7: Close up view of *Agreement Details* from *Agreements in Time and Space*.

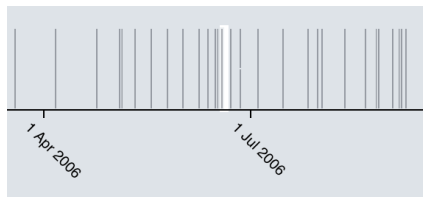


Figure 8: A clicked PA highlighted in white on the *Agreements in Time and Space* timeline.

6). PAs visualized on the timeline and map are filtered simultaneously. When a user hovers over a peace agreement on the timeline or map, details of the agreement appear in the left sidebar (Figure 7). When a user clicks a peace agreement on the timeline or map, the agreement becomes highlighted on the timeline (Figure 8) and enlarged on the map (Figure 5), and its details remain displayed in the left sidebar (Figure 7).

Agreement Sequence Comparison visualizes peace agreements in three timelines (Figure 9). Users can choose to visualize the peace agreements of up to three locations using the dropdown menus above each timeline (Figure 10). The timelines visualize the chronology of PAs from 1990 through 2015, the entire time scale PA-X covers. Users can choose a subset of PAs to visualize on each timeline using a filter in the left sidebar (Figure 11). PAs are color coded by their associated Agreement Stage, one of the 255 metadata fields (Figure 12). As with the previous visualization, PAs can be hovered and clicked to display their details.

The visual and interaction design decisions for the PaxVis visualizations involved sketching sessions with end users, prototyping static visualizations with Adobe Illustrator, and iteratively developing interactive visualizations with D3.js and MapBox. The research focuses of end users determined which metadata fields in PA-X to visualize, and the geographic and temporal dimensions over which to visualize the PA-X data. To explain how the visual and interaction design decisions support end users' research, the following section describes how a peace researcher could use PaxVis while investigating the question, *How common a topic is "Women, Girls and Gender" in peace agreements?*

Step 1: Contextualizing. Initially the researcher needs to understand the context of her research. *Agreements in Time and Space* displays all PAs in PA-X upon initially loading. A timeline displays PAs in chronological order and a map displays PAs by the location of the corresponding peace processes (Figure 1). The researcher clicks the code for "Women, Girls and Gender" to filter the visualized PAs so the timeline and map display only PAs that address that code. Many peace agreements disappear from the map, though PAs addressing Women, Girls and Gender remain in every region of the world that had PAs prior to filtering.

Step 2: Selecting Case Studies The researcher then wonders whether different regions of the world take different approaches to addressing Women, Girls and Gender in PAs. Looking at the map, she picks three countries, each from a distinct region, over which PAs are visualized: Colombia, Sudan and the United Kingdom. Moving to the *Agreement Sequence Comparison* visualization, the researcher selects one of these locations to display in each of the three timelines (Figure 9). These timelines visualize PAs as rectangles, color-coded by the peace process stage during which the PA was written (Figure 10). Similarities and differences in each country's sequence of PAs are readily apparent. All countries have PAs spread throughout the length of the timelines, however the stages associated to each PA vary: Colombia has many "Prenegotiation" (teal) PAs, Sudan has many "Framework partial, substantive" (yellow) and "Ceasefire/related" (red) PAs, and the United Kingdom has many

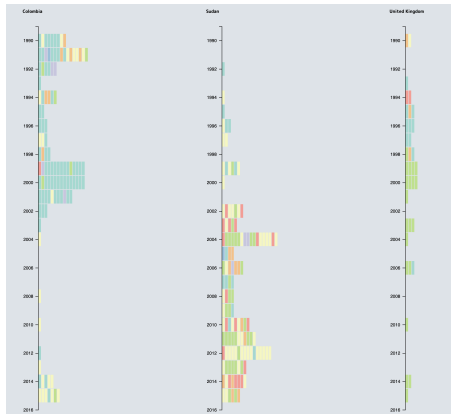


Figure 9: From left to right: Colombia, Sudan and the United Kingdom visualized in Agreements Sequence Comparison.

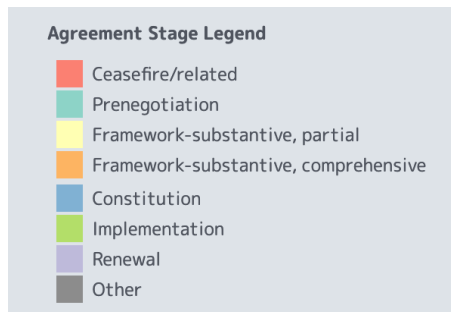


Figure 10: The Agreement Sequence Comparison legend.

¹²www.politicalsettlements.org

“Implementation” (green) PAs. The researcher then clicks the Women Girls and Gender code to filter the PAs visualized on the timelines (Figure 11).

Step 3: Close Reading Having obtained a high-level understanding of how PAs address Women, Girls and Gender around the world and over time; and having selected three locations that each take a distinct approach to addressing Women, Girls and Gender in their PAs, the researcher is now ready to conduct a close reading. Clicking PAs from each timeline, she downloads PDFs (Figure 16) to compare the language regarding Women, Girls and Gender used in Colombia, Sudan and the United Kingdom.

5. DISCUSSION AND FUTURE WORK

Visualizations for Peace. The flexibility of D3.js and MapBox enabled us to tailor the PaxVis visualizations to our end users: peace researchers and negotiators. Their flexibility also introduced communication challenges, though. Authors working on visualizations needed to show end users several possible implementations before the team could reach final design decisions. In future interdisciplinary visualization projects, a library of interface and interaction design possibilities for end-users to browse could mitigate visualization-related communication challenges. Ongoing challenges to address in future PaxVis work include visualizing similarities between PAs, visualizing more than eight dimensions per PA, and improving clustering methods for PAs on the map.

Data-driven Peace Negotiations. At an international workshop on inclusive peace processes, we presented PaxVis to peace negotiators. The negotiators stated that to obtain a realistic picture of conflicts and peace processes, they rely on data about events, public opinion, parties in conflict and negotiation statuses. To further develop PaxVis we continue to seek feedback from scholars, mediators, activists and policy makers about the role of precise and up-to-date data on peace processes.

Interviews with PaxVis. Through interviews we will learn how to tailor PaxVis to the different needs of peace process participants. Feedback from peace negotiators to date indicates that researchers and policy makers have distinct visualization needs. Researchers need customization options for exploring historical trends and open-ended research questions. Policy makers need visualizations that make common topics in recent PAs readily apparent, and that track events impacting peace processes in which policy makers participate. Eventually, we imagine PaxVis as a platform for public engagement and storytelling to improve awareness and perceptions of peace processes.

ACKNOWLEDGMENTS

This is an output from the Political Settlements Research Programme¹² funded by the Department of International Development (DFID) UK Aid. Nothing herein reflects the views of DFID.

The authors thank the Political Settlements Research Programme (especially Sanja Badanjak, Kevin McNicholl, Robert Forster, Astrid Jamar, Kathryn Nash and Laura Wise) for contributing to PaxVis.

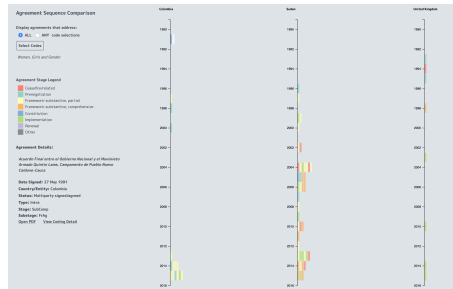


Figure 11: Agreements Sequence Comparison visualizing Colombia, Sudan and the United Kingdom with the filter Women, Girls and Gender selected.

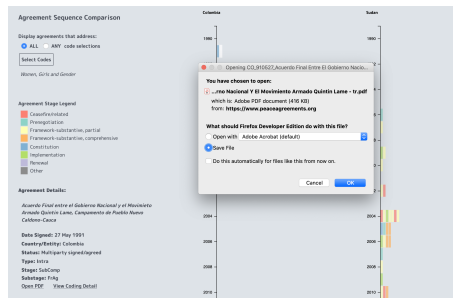


Figure 12: The download dialogue box that appears after clicking the Open PDF link in Agreement Details.

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